

THE
Malayan Agricultural Journal.

Vol. XIII.]

SEPT., 1925.

[No. 9.]

BUD-GRAFTING.

IN the current number of the *Archief* Dr. Heusser continues his records of the "Experimental tapping on *Hevea* buddings" of which the first and second series were published in January and July last year.

Although the present publication deals with a limited number of trees, the results are of the greatest interest and justify quotation in full.

The clones dealt with in this paper are Avros 33, 36, 50, 52 and 80—further communications are promised giving the results of tapping the other approved clones mentioned in the former reports.

To quote from Dr. Heusser :—

Period of tapping.—The first tapping took place in the spring, the second in the autumn of 1923. In the beginning of 1924 alternate monthly tapping was started and this system has been continued up to the present time. Beginning with the third tapping, as a rule, the buddings were tapped for 25 consecutive days, which works out at 150 tapping days per year.

Tapping cut.—The left cut over half the circumference and the angle of 30° remained the same.

Height of tapping.—The second, third and fourth tapping of clones 33 and 50 was continued on the tapping panel of the first period, which started at a height of 50 c.M. above the union of scion and stock. With the fifth period the panel was changed to the opposite side at a height of 1 M. In the case of clones 36, 52 and 80 the change to 1 M. was made immediately after the second tapping period.

Bark consumption—Care was taken that the bark consumption on an average amounted to 4.5 c.M. ($1\frac{1}{2}$ ") per period of 25 days, i.e. 27 c.M. ($10\frac{1}{2}$ ") per year.

Tappers.—The buddings were tapped alternately by two moderately good tappers, who were trained by us.

" *Determining the production.*—The latex was coagulated in the cup, the coagulum pressed out by hand and fixed on a piece of wire, bearing a zinc label with the number of the tree. After the completion of a tapping period the whole production of each budding was worked up in one piece of crepe, which was numbered and weighed after drying. The average yield per tapping was calculated from the monthly total weight. In this way the supervision of the experimental tappings was considerably simplified.

The tables.—In the tables the average yields per tapping for each period are given in grams of dry rubber. For the sake of completeness the averages of the first tapping are also given. Further the average yield per year and per tapping of the last six tappings, covering one year, is given. For most of the buddings from clones 33, 50, 52 and 80 this is the 6th year of life; for clone 36 it is from 4½ till 5½.

The circumferences of the buddings at a height of 1 M. are also inserted in the tables, because they are to some extent a criterion for the circumstances in which the trees are growing.

(See following tables.)

II. THE YIELDS.

The yield of the buddings increases quickly with the increase of age, a feature also shown by ordinary seedlings of the same age.

Comparing the yields during the months of January or February 1924 with those of the same months of 1925, we see that the yields of clones 36 and 50 are rather more than doubled, and those of clones 33 and 52 nearly doubled. The yield of clone 80 however increases remarkably slowly as compared with the other clones, notwithstanding its vigorous growth.

As to the yield of the individual buddings, tree No. 13 of clone 50 reached the highest yield in the month of March 1925 with 48.76 grams per tapping. The other buddings with a circumference of more than 70 c. M. are not much behind tree No. 13 and it seems that they will become equal to the mother tree.

The correlation between trunk circumference and production is shown clearly. As a rule deviations may be explained externally. For instance tree No. 21 of clone 50 with a low branching and tree No. 16 of clone 33, which was damaged by wind, have a trunk circumference which is too large in proportion to the crown (the part of the tree which really matters). Disturbances in the production also occur during the months of February, March and April, the wintering period of *Hevea* on the East coast of Sumatra. The larger yields of some of the buddings from clones 33 and 50, when the height of tapping was changed from 40 c.M. to 1 M, must not be wrongly interpreted; the time of changing the height of tapping coincided with the wintering month March and the normal production month May.

No influence of the stock on the production of the buddings can yet be detected from the tapping results.

Regarding the yielding power of the individual clones during a whole year, April 1924—April 1925, or March 1924—March 1925 respectively the following comment may be made.

Clone 33.—The average yield of the 11 buddings from this clone which were tapped, amounted to 14.68 grams of dry rubber per tapping, the average circumference being 52 c.M.

The production during the whole year, which is with exception of two younger trees, the 6th year, was 2.29 K.G. per tree, the total of tapping days being 156.

The average yield per 10 c.M. circumference is 2.84 grams per tapping.

Leaving out of account trees No. 8 and 22 which are younger, the average yield per tapping is 16.3 grams and the yearly production 2.54 K.G.

Clone 36.—The 12 buddings from this clone on an average produced 11.16 grams of dry rubber per tapping per tree in the 44-54 year, the average circumference being 50.25 c.M. The trees were tapped on 128 days only, so the yearly production per tree amounted to 1.43 K.G. only. Expressing the yield per unit of circumference a figure of 2.22 grams per day per 10 c.M. circumference is attained.

Clone 50.—Of 10 buddings of this clone tapped during the year April 1924—April 1925 seven were in the sixth year and three about 1 year younger. The average yield per tapping and per tree was 20.11 grams of dry rubber, the average circumference 64.7 c.M. With 156 tapping days a yearly production of 3.14 K.G. rubber per tree was attained.

Per 10 c.M. circumference the yield amounted to 3.11 grams.

If in calculating the average yield trees No. 1, 11 and 24 which are younger, are not included, the averages per day and per year are 24.59 grams and 3.82 K.G.

Clone 52.—The average yield of the 11 buddings from this clone was 12.98 grams of dry rubber during the 6th year, the average circumference being 60.9 c.M. For the whole year, 154 tapping days, this means a production of 2.0 K.G. per budding.

Per 10 c.M. circumference a yield of 2.13 grams is calculated.

Clone 80.—The 9 buddings from this clone produced 13.04 grams of dry rubber per tree and per day, on an average circumference of 63.3 c.M. The production in one year with 154 tapping days is 2.04 K.G. per budding, and the daily yield per 10 c.M. circumference 2.06 grams.

"III. CONSIDERATIONS IN CONNECTION WITH THE BUDDING PROBLEM.

Yield.—The yield of the clones is better than we expected. A well kept up plantation of seedlings from selected seed of the same age produced 8 grams per day, the tapping system being the same. Clone 50, now our best, produces $2\frac{1}{2}$ times as much, notwithstanding the fact that the buddings were tapped at a height of 86 c.M. and the seedlings lower than 50 c.M.

Growth.—The growth of the crown and trunk leaves nothing to be desired; the buddings have become true rubber trees, showing the characteristics of the mother trees. Measurements of the circumferences show, that clone 50 is the most vigorous grower. Clones 80, 52 and 36 follow in this respect; clone 33 grows a little more slowly.

The union of scion and stock.—It seems that the elephant foot of the buddings becomes less pronounced as the plants grow older. A difference between the clones may however still be seen and will probably remain. The union is best in clone 50; the difference in growth of scion and stock is least visible with this clone. Clone 80 also unites well, 36 and 52 not quite so well, while clone 33 shows the elephant foot most clearly.

Bark renewal.—Of much more importance than the union, but probably related to it, is the renewal of the bark. Generally speaking this seems to be a little less vigorous than that of well growing seedlings, which are tapped for the first time. This is not so with clone 50 however; the bark renewal of this clone is as good as that of seedlings. The oldest, now 2 years old, renewed bark has an adequate thickness and the panels are beautifully arched and without edges or holes, as is sometimes seen when bark renewal is bad. Also clones 80, 52 and 36 give no cause for uneasiness. Only clone 33, standing on a clay soil, gives the impression that it renews the bark more slowly. In choosing a tapping system for buddings I deem it advisable however to reckon upon a 10 years period for the primary bark.

Fructification.—Clones 36, 33, 50 and 52 bear fruit abundantly. Till now clone 80 has remained sterile, though it has produced many flowers and another flowering clone stands in the same seed garden.

IV. CONCLUSIONS FOR ESTATE PRACTICE.

In foregoing communications we have advised the use of both buddings and seedlings for new plantations and the planting of these in alternate rows. The above results plead for the abandonment of this point of view and the planting, in the near future, of plantations of buddings only, using clones which are equivalent to the clones described here or still better ones. Only legitimate seedlings and those originating from strictly selected mother trees now deserve to be planted and give any prospect of the same production as buddings from good clones, and even so certainty is not yet obtained, and the productive capacity must be determined for each tree separately. Moreover the available quantity of selected seeds during the next

"years will be limited and insufficient for the new extensions, so in practice one is compelled to use ordinary or only slightly selected seed. Instead of using such seedlings it is much better to plant buddings of good clones exclusively. The advice to plant the different clones well mixed is still maintained, and a warning must be given against planting one clone only.

Under good conditions the yield of a six year old plantation of buddings from the above mentioned or equivalent clones may be estimated at about 400 K.G. per H.A." (about 360 lbs. per acre). "If with the increase in years the production of buddings improves with the same intensity as that of seedlings we may expect the double quantity from a ten years old plantation, or about 800 K.G. per H.A." (about 710 lbs. per acre).

Dr. Heusser's whole hearted advocacy of bud-grafting is noteworthy and is the more striking in view of his former cautious attitude²—and of the conservative estimates of yield quoted above. The only criticism which can be made is that the results quoted were from a small number of trees presumably planted and grown under very good conditions, and that even in this small number of clones (five), the best of the original thirty-nine—one has at this stage shown a very low rate of increase of yield.*

From a strictly critical point of view it would seem safer to say that the results indicate that the second stage of the experiment has been successfully passed (the first stage being the realisation that not all high yielders "bud true") and that there is good hope of a successful final issue.

For Malaya, this means that the search for 'true' mother trees should be actively pursued, and in this connection the advice given in this Journal³ in 1923 still holds good. By the time that our trees have been 'proved' it should be possible to have definite information as to the ultimate degree of success attained by bud-grafting with 'proved strains.'

One fact emerges from these results which may have some bearing on recent suggestions for very close planting of unproved strains, and (presumably) subsequent thinning—viz. that while in any clone 'yielding power' $\frac{(\text{Yield})}{(\text{Girth})}$ is uniform—*yield* is very decidedly not uniform. From this it seems fair to deduce that high actual yield is much more closely connected with girth than is the case with seedlings and therefore that ample space for full development is necessary for the real capacity of any tree to be ascertained. Failing such wide spacing, it might be possible for accidental variations of soil, 'get away,' and the like, to lead to misleading conclusions from early tappings.

2 c.f. M.A.J., XII No. 9 p 344, 1924.

* a fact pointed out by Dr. Heusser himself.

3. M.A.J., XI No. 2 p 29 1923.

No.	Clone Avros 33	Average yield per tapping day in grams during the month of												Average 4-24-4-25
		March '23	Oct. '23	Jan. '24	March '24	May '24	July '24	Sept. '24	Nov. '24	Jan. '25	March '25			
		Height of tapping in c.M.												
		50	46.5	43	40	100	95.5	91	86.5	82	77.5			
Budding		Number of tapping days												
		20	20	15	28	28	28	25	25	25	25	Total 156		
1	Yield	5.90	7.23	14.16	13.67	12.55	12.02	14.00	17.60	25.46	23.70	17.56		
	Circumference	39	47	—	50	—	—	56	—	—	—	56		
2	Yield	6.30	6.65	12.51	6.82	9.58	8.43	11.96	13.72	21.60	18.48	13.96		
	Circumference	40	44	—	48	—	—	52	—	—	—	52		
6	Yield	4.13	5.62	8.34	6.98	10.80	9.03	12.36	14.84	19.24	18.76	14.17		
	Circumference	33	41	—	44	—	—	50	—	—	—	50		
8	Yield	—	3.35	7.11	3.72	6.36	5.37	7.33	11.26	14.42	12.16	9.48		
	Circumference	—	33	—	36	—	—	42	—	—	—	42		
11	Yield	8.79	8.90	15.59	9.50	15.09	12.90	19.20	22.24	30.72	28.52	21.45		
	Circumference	47	53	—	56	—	—	60	—	—	—	60		
13	Yield	2.64	4.59	9.25	5.26	8.09	8.14	10.46	13.16	19.60	16.10	12.59		
	Circumference	22	43	—	47	—	—	50	—	—	—	50		
15	Yield	6.13	7.39	11.29	8.44	11.40	11.21	12.46	17.08	23.88	19.84	15.98		
	Circumference	34	39	—	44	—	—	49	—	—	—	49		
16	Yield	5.09	5.71	10.40	6.22	7.82	7.42	10.50	10.96	15.40	14.10	11.03		
	Circumference	43	50	—	54.5	—	—	61	—	—	—	61		
18	Yield	7.63	8.99	17.49	15.21	13.82	11.80	19.06	22.12	30.60	25.40	20.47		
	Circumference	43	50	—	54	—	—	59	—	—	—	59		
22	Yield	—	2.89	7.11	3.04	3.45	3.65	5.34	6.20	9.20	7.24	5.85		
	Circumference	—	33	—	37	—	—	38	—	—	—	38		
23	Yield	7.97	7.97	13.31	9.74	11.80	13.15	18.38	19.99	26.28	23.84	18.90		
	Circumference	42	47	—	50	—	—	55	—	—	—	55		
	Average	6.06	6.30	11.51	8.05	10.07	9.37	12.82	15.38	21.49	18.92	14.68		
	Circ.	39.2	43.3	—	47.2	—	—	52.7	—	—	—	52		

No.	Clone	Average yield per tapping day in grams during the month of												Average 4-24-4-25
		March '20	Oct. '23	Jan. '24	March '24	May '24	July '24	Sept. '24	Nov. '24	Jan. '25	March '25			
		Height of tapping in c.M.												
		50	46.5	43	40	100	95.5	91	86.5	82	77.5			
		Number of tapping days											Total 156	
		20	20	15	28	28	28	25	25	25	25			
1	Yield	—	2,04	5,37	6,18	4,57	5,10	8,13	9,14	12,84	13,32	8,85		
	Circumference	...	31	—	38	—	—	44	—	—	—	44		
11	Yield	—	2,47	5,38	5,47	6,15	7,12	10,78	12,66	14,74	16,24	11,28		
	Circumference	...	36	—	41	—	—	48	—	—	—	48		
12	Yield	4,92	10,36	16,65	17,76	10,70	13,25	24,00	20,60	30,78	26,40	20,96		
	Circumference	48	55	—	61	—	—	69	—	—	—	69		
13	Yield	8,39	10,74	16,74	13,78	19,48	21,39	29,77	23,92	38,80	48,76	31,18		
	Circumference	58	64	—	69	—	—	75	—	—	—	75		
14	Yield	10,20	11,39	21,56	17,79	20,38	16,30	25,82	28,56	43,20	41,94	29,37		
	Circumference	58	66	—	71	—	—	79	—	—	—	79		
16	Yield	3,76	6,50	14,11	14,07	9,89	13,02	17,59	16,22	24,98	24,96	17,78		
	Circumference	46	52	—	55	—	—	62	—	—	—	62		
20	Yield	9,30	10,39	20,39	11,11	17,62	19,43	27,48	26,84	38,48	36,48	27,72		
	Circumference	60	66	—	69	—	—	75	—	—	—	75		
21	Yield	7,03	9,88	14,97	11,10	19,66	20,06	24,60	26,48	37,72	25,80	25,72		
	Circumference	55	66	—	71	—	—	77	—	—	—	77		
23	Yield	5,52	6,89	14,24	13,36	12,62	14,03	19,60	20,36	27,68	22,26	19,43		
	Circumference	63	61	—	67	—	—	74	—	—	—	74		
24	Yield	—	2,27	4,41	8,18	5,09	6,40	8,83	8,98	13,42	9,97	8,78		
	Circumference	...	31	—	38	—	—	44	—	—	—	44		
Average Yield		7,02	7,29	13,38	11,38	12,62	13,61	19,66	19,88	28,26	26,61	20,11		
Average Circ.		54	5,27	—	57,9	—	—	64,7	—	—	—	64,7		

20,11
64,7

No.	Clone <i>Avros 36</i> Budding	Average yield per tapping day in grams during the month of												Average 3-'24--3-'25	
		Jan. '23	Oct. '23	Febr. '24	April '24	June '24	Aug. '24	Oct. '24	Dec. '24	Febr. '25					
		Height of tapping in c.M.													
		50	46	100	96	92	88	84	80	76				86	
Number of tapping days														Total 128	
		20	20	19	21	18	22	23	23	21					
1	Yield	0,89	3,58	4,98	5,74	5,75	8,48	11,08	13,17	13,74					9,66
	Circumference	25	33	—	—	—	—	46	—	—					46
2	Yield	3,90	7,51	8,50	5,03	9,76	11,54	14,35	19,50	11,05					11,87
	Circumference	33	39	—	—	—	—	49	—	—					49
3	Yield	4,02	7,08	3,68	5,74	2,81	7,23	7,67	12,61	11,33					7,90
	Circumference	35	41	—	—	—	—	48	—	—					48
4	Yield	3,23	4,76	7,32	4,76	4,20	8,97	9,09	5,29	4,62					6,16
	Circumference	35	41	—	—	—	—	51	—	—					51
6	Yield	3,25	3,72	5,98	3,06	5,93	7,22	9,78	14,02	13,52					8,92
	Circumference	33	36	—	—	—	—	49	—	—					49
7	Yield	3,47	6,67	8,29	8,41	9,63	13,27	15,25	20,09	19,14					14,30
	Circumference	35	42	—	—	—	—	53	—	—					53
17	Yield	3,31	8,26	3,05	8,40	7,85	12,90	16,72	20,53	12,63					13,17
	Circumference	36	42	—	—	—	—	52	—	—					52
20	Yield	3,24	5,65	7,91	9,43	11,12	11,13	17,08	21,95	18,43					14,86
	Circumference	39	44	—	—	—	—	56	—	—					56
23	Yield	—	3,54	4,68	6,28	7,42	10,60	13,83	18,15	11,46					11,29
	Circumference	—	—	—	—	—	—	50	—	—					50
25	Yield	2,97	4,83	5,79	7,74	7,59	11,45	15,56	20,53	18,14					13,50
	Circumference	31	37	—	—	—	—	48	—	—					48
27	Yield	—	9,35	6,27	9,62	8,92	14,04	15,60	24,04	17,12					14,89
	Circumference	—	—	—	—	—	—	55	—	—					55
33	Yield	—	—	—	—	1,95	5,59	7,40	12,28	10,51					7,55
	Circumference	—	—	—	—	—	—	46	—	—					46
Average		3,14	5,90	6,04	6,75	6,92	10,20	12,78	16,85	13,47					11,16
Yield		33,5	39,4	—	—	—	—	50,25	—	—					50,25
Circ.		—	—	—	—	—	—	—	—	—					—

No.	Clone	Average yield per tapping day in grams during the month of												Average 3—'24—3—'25
		Febr. '23	Oct. '23	Dec. '23	Febr. '24	April '24	June '24	Aug. '24	Oct. '24	Dec. '24	Febr. '25			
		Height of tapping in c.M.												
		Number of tapping days												
	Budding	50	46,5	100	96,5	92	87,5	83	78,5	71	69,5	78,5	Total 154	
		20	20	14	20	28	26	25	25	25	25			
1	Yield Circumference	6,30 40	7,90 48	7,94 —	8,21 —	3,80 —	7,29 —	7,64 —	6,80 55	4,32 —	1,46 ¹ —	5,22 55		
3	Yield Circumference	3,98 38	6,69 49	8,71 —	9,96 —	7,96 —	8,17 —	8,92 —	10,25 60	13,54 —	12,50 —	10,22 60		
4	Yield Circumference	8,59 51	11,50 56	15,03 —	16,83 —	9,92 —	16,85 —	14,54 —	21,04 65	16,50 —	12,62 —	15,25 65		
6	Yield Circumference	3,75 38	9,23 46	9,72 —	9,64 —	8,74 —	9,51 —	8,96 —	10,72 57	16,12 —	15,34 —	11,57 57		
11	Yield Circumference	5,93 39	8,96 43	7,59 —	8,80 —	6,35 —	8,44 —	8,54 —	9,22 51	11,20 —	9,26 —	8,84 51		
14	Yield Circumference	4,65 46	9,50 52	12,34 —	12,35 —	7,36 —	11,78 —	12,14 —	13,48 67	11,04 —	15,06 —	11,81 67		
16	Yield Circumference	13,66 63	17,40 72	21,53 —	24,41 —	14,82 —	22,01 —	20,22 —	26,16 82	29,64 —	33,16 —	24,34 82		
22	Yield Circumference	7,85 50	11,09 55	13,35 —	13,89 —	8,10 —	11,96 —	11,84 —	14,28 63	13,40 —	14,58 —	12,36 63		
25	Yield Circumference	10,54 52	14,09 60	14,48 —	15,92 —	12,68 —	17,59 —	15,32 —	18,28 70	21,48 —	21,06 —	17,74 70		
	Average Yield Circ.	7,25 46,3	10,74 54,5	12,30 —	13,17 —	8,86 —	12,62 —	12,01 —	14,47 63,3	15,25 —	15,00 —	13,04 63,3		

¹) Part of the crown lost in consequence of Djamoer oepas (Oortium).

No.	Clone	Average yield per tapping day in grams during the month of												Average 3--24--3--25
		Febr.												
		Oct.												
		Dec.												
		Febr.												
Avros 52														
Badling														
Height of tapping in c.M.														
Number of tapping days														
Total 154														
3	Yield	6,69	8,39	4,46	7,46	6,26	9,08	7,44	14,16	14,12	22,60	12,28		
	Circumference	42	45	—	—	—	—	—	53	—	—	53		
4	Yield	10,30	17,22	11,10	8,42	7,26	11,66	14,70	17,80	16,72	20,96	14,85		
	Circumference	51	57	—	—	—	—	—	66	—	—	66		
5	Yield	4,44	5,76	3,15	3,76	5,71	9,02	8,12	9,12	11,12	11,24	9,06		
	Circumference	37	43	—	—	—	—	—	50	—	—	50		
6	Yield	11,18	15,54	11,84	15,41	10,01	15,72	17,14	17,32	13,68	19,60	15,58		
	Circumference	56	62	—	—	—	—	—	69	—	—	69		
10	Yield	9,43	14,54	11,79	13,45	8,94	14,57	16,52	20,36	22,70	24,28	17,90		
	Circumference	50	54	—	—	—	—	—	63	—	—	63		
11	Yield	9,38	8,96	8,79	12,02	9,94	10,87	10,80	12,64	11,32	16,94	11,75		
	Circumference	49	54	—	—	—	—	—	61	—	—	61		
14	Yield	3,27	7,16	6,97	7,84	6,71	7,92	8,38	9,16	10,72	14,76	9,61		
	Circumference	36	44	—	—	—	—	—	57	—	—	57		
15	Yield	5,84	8,42	12,21	14,17	8,56	12,80	12,96	14,48	13,56	22,80	14,19		
	Circumference	48	56	—	—	—	—	—	66	—	—	66		
18	Yield	7,30	9,45	9,52	12,88	9,94	10,48	11,46	12,32	12,82	21,26	13,05		
	Circumference	45	54	—	—	—	—	—	62	—	—	62		
20	Yield	2,77	7,47	6,99	5,71	4,90	7,32	8,34	10,92	10,86	14,66	9,50		
	Circumference	33	45	—	—	—	—	—	57	—	—	57		
21	Yield	8,63	15,03	11,42	11,53	9,84	14,26	13,88	16,20	22,10	13,60	14,98		
	Circumference	49	56	—	—	—	—	—	66	—	—	66		
Average		7,00	10,72	8,93	10,24	7,82	11,25	11,79	14,04	14,52	18,43	12,98		
Yield		45	51,8	—	—	—	—	—	60,9	—	—	60,9		
Circ.														

TAPPING SYSTEMS AND OTHER FACTORS INFLUENCING YIELD OF *HEVEA BRASILIENSIS*.

BY F. G. SPRING.

THIS article is based on the results of tapping experiments carried out on numerous rubber estates throughout the Peninsula, results of which were kindly supplied to the Department of Agriculture.

The writer is not familiar with the conditions under which the experiments were conducted and cannot therefore make any comment as to the accuracy of the results. Unfortunately little information was given in respect of many of the tests and in several instances the results had to be omitted owing to the absence of sufficient data.

Tapping experiments require special knowledge in their preparation and a high standard of supervision. It is not proposed here, however, to deal with the principals which should govern field tests with the rubber tree but merely to draw attention to the fact that there are many problems to be considered since so many factors have a direct influence on the yield of latex. If any estate Manager contemplates conducting tapping experiments it is advisable that he should first consult the Department of Agriculture.

Yields during wintering and at other times.

The following comments were made on the results obtained on six estates.

Estate 1.—"The best yielding period is from October to the middle of February. The crop, during the wintering season, decreases to a greater extent on flat land than on undulating land."

Estate 2.—"The crops steadily fall off from March and do not recover until the trees have put on fresh foliage, which is usually during the month of June. Should a period of drought be experienced the yields will be affected, provided the duration of the drought is sufficiently long, say two weeks."

Estate 3.—"The best yielding month is December"
"The poorest yielding month is April."

Estate 4.—"There is less falling off in yield due to wintering with alternate day tapping as compared with daily."

Estate 5.—"The harvests generally begin to fall away, owing to leaf change (wintering) about the middle of February until the crop reaches its lowest point towards the end of March. Two or three weeks later, a slight increase in crop is noticed and this increase is generally steadily maintained until the crop becomes normal about

the middle or end of May. The influence of wintering is felt over a period of around $3\frac{1}{2}$ months. A spell of dry weather before wintering commences is responsible for fairly regular leaf fall throughout the estate. Heavy rains immediately preceeding the wintering season induce trees to retain old foliage longer than they would otherwise. Under such circumstances, wintering is not only retarded but often very irregular and the period over which poorer yields are obtained, is extended. The output almost invariably touches its lowest point when the new foliage is bursting. The best yielding months are November, December and January."

Estate 6.—"The crop drops considerably during the wintering season and if the wintering is heavy, the reduction may be as high as 50%. The crop is larger during wet weather, provided the rains do not interfere with tapping to any great extent."

HOURLY OF TAPPING.

The following comments were made on the results obtained on 5 estates.

Estate 1.—Late tapping produces about 60% of a normal crop obtained from early tapping.

Estate 2.—With late tapping, the output from any daily system is more adversely affected than in the case of alternate day tapping.

Estate 3.—A loss of from 25 to 40% of the crop is experienced when tapping is started late. Afternoon tapping (vacant tasks) gives approximately 60% of normal yields.

Estate 4.—The yield obtained, when tapping was commenced at 2 p. m., never exceeded 50% of a normal day's crop.

Estate 5.—Late tapping is responsible for a loss in crop of 25% of the yield obtained from early tapping.

It has been proved in Java and Sumatra¹ that early tapping produces a higher yield than later in the day and that the yield decreases especially after 9 a.m.

DAILY VERSUS ALTERNATE DAY TAPPING.

A few years ago, daily tapping was popular throughout the Peninsula but the majority of estates here are now working on the alternate day system which is a more economical one and a few on periodical tapping. Some experiments have shown that alternate day tapping produces about 70% of the yield as compared with daily, over a period, with equal lengths of tapping cut but if the length of the cut in the alternate day system be increased, a more favourable comparison does it make.

1 Dr. J. G. J. A. Mass, *Archief*, January 1925, page 215.

The Mycologist S.S. and F.M.S. is of opinion that alternate day tapping from the disease point of view is to be recommended in preference to any system of daily tapping. R. M. Richards has also expressed a similar opinion.¹

Estate 1.—A test was conducted over a period of two years to compare the yields obtained from a quarter cut daily and from a V cut alternate day. The fields are similar in size and the cuts were practically at the same height from the ground.

System.	Yield 1st Year	Yield 2nd Year.
$\frac{1}{4}$ cut daily	595 lbs per acre	563 lbs per acre
V cut Alternate day	605 „ „ „	703 „ „ „

It will be seen that as tapping continues the more favourable does the yield of the alternate day system become. With the V, there was a saving of just over $1\frac{1}{2}$ cents per lb. in cost.

Estate 2.—On this property the system was changed from a fairly low, daily third cut, to an alternate day $\frac{1}{2}$ cut. After six months tapping approximately 95% of the former crop was obtained.

Estate 3.—The system was changed from a third cut daily to $\frac{1}{2}$ cut alternate day and the new system yielded approximately 90% of the former crop.

Estate 4.—During the year 1920 the trees were tapped daily on the quarter cut and during 1921 and 1922 they were tapped alternate daily on the $\frac{1}{4}$ cut.

Year.	Yield per Acre.	Yield per Tree.	Cost of Tapping.
1920	220 lbs.	2.66 lbs.	9.04 cents.
1921	203 „	2.59 „	5.62 „
1922	257 „	3.28 „	4.81 „

The yields for 1922 are calculated on seven months results.

Estate 5.—When the trees were 10 years old a change was made from daily to alternate day tapping, quarter cut. It is reported that 15 to 16 year old trees are producing rather more on a $\frac{1}{4}$ cut, alternate day tapping, than they did at the age of 10 to 11 years when they were tapped daily.

TAPPING AT INTERVALS OF MORE THAN TWO DAYS.

Numerous experiments have been carried out to enquire into the prospects of tapping at intervals of more than two days but there is not sufficient evidence to enable definite recommendations to be made.

¹ Lectures delivered at the Planters' Conference, Kuala Lumpur, July 1924, page 52.

Estate 1.

SYSTEM OF TAPPING V ON HALF THE CIRCUMFERENCE.

Area.	System.	Total Yield.	Yield per Acre.	No. of tapping months.
(1) 10 acres	Alternate day.	2765 lbs.	276 lbs.	10
(2) 20 acres	every 3rd day.	5341 ,,	267 ,,	11
	(1) Bark consumption at the rate of 9" per annum.			
	(2) ,, ,, ,, ,, 6" ,, ,,			

In (1) tapping was conducted over a period of 10 months whereas in (2) the period was 11 months.

The land is flat and of a clay texture.

Estate 2.--Two superimposed $\frac{1}{2}$ cuts tapped every 3rd day yielded 47.70 per cent of the crop obtained from 2 superimposed cuts $\frac{1}{2}$ circumference daily tapping over a period of two years (5592 lbs. against 11724 lbs.) The higher cut being 36 inches and the lower cut 20 inches from the ground. The areas are similar in size and appearance. One experiment carried out in Ceylon showed that the relation in yield between alternate day tapping and tapping every third day to be approximately 5 to 4. The system was one cut half the circumference of the tree in both cases.

PERIODICAL TAPPING.

On one estate in Malaya the yields obtained, per acre, over a period of 12 months, on alternate month tapping, were higher than that obtained from alternate day tapping but on another estate the Manager reports that he discontinued the daily tapping with periods of rest as the results were so inferior to that obtained from alternate day tapping.

In the Archief, Januari, 1925, page 218 it is reported "For the time being the conclusions arrived at are that resting periods may vary from $\frac{1}{2}$ to 2 months, but that these may not last longer than two months, whilst the tapping periods should not be shorter than one month and not longer than two months. The record of the daily yields and the changes as far as the rubber content of the latex is concerned, furnish indications as to the proper duration of the tapping periods as compared with the duration of the preceeding resting."

"As regards the influence of resting periods on the intrinsic characteristics of the rubber, De Vries stated that resting periods of more than two months only caused marked deviations in the uniformity. Uniformity should however not be taken for quality and it should further be kept in mind that not all the sections of an estate are rested at the same time and therefore latex obtained from

trees which have just been rested, is mixed in the factory with latex from other sections."

A. B. C. SYSTEM.

In the A. B. C. system the area is divided into three equal divisions and each tapped in turn for equal lengths of time, the trees are therefore rested for double the time they are in tapping. The period over which tapping should be continued has not been definitely decided. The following are the results obtained with the A. B. C. system on one cut half the circumference of the tree daily tapping, as compared with the control plots which were tapped on alternate days on half the circumference of the tree:—

Estate A.	A.B.C. system	yielded	69%	of the crop of the control.
" B.	"	"	62%	" " " " " "
" C.	"	"	72%	" " " " " "
" D.	"	"	80%	" " " " " "
" E.	"	"	81%	" " " " " "
" F.	"	"	67%	" " " " " "
" G.	"	"	80%	" " " " " "

One Manager who tried this system for two years came to the conclusion that he obtained 81% of normal output with 66% of the labour and bark. Mr. C. R. Harrison of Midlands Estate, Klang, delivered an interesting lecture at the 2nd Planters' Conference, Kuala Lumpur on Periodic Tapping in which he dealt with a system of tapping evolved by himself namely alternate day A. B. C. on half the tree. The method is to divide the area into three equal parts called for convenience A.B.C. Tap sections A & B on alternate days, while C is rested. Stop tapping A section after a fixed period, then tap B—C and so on. This lecture will no doubt be published.

NUMBER OF CUTS TO A TREE.

It is reported that an experiment was started on June 1st 1914, and continued until the end of 1917, the object being to record the difference in yields obtained from a single cut on the quarter, and from two cuts on a quarter; daily tapping in both cases. The trees were 7 years old at the time the experiment was started, the appearance of the trees in both areas was very similar, and as far as could be judged, all other conditions were equal.

The average amount of No. 1 rubber collected, per coolie, during each year was:—

Year.	Average yield per cooly per annum obtained from 2 cuts on the quarter.	Average yield per cooly per annum obtained from a single cut on the quarter.
1914	671.07 lbs. (for 7 months)	643.55 lbs. (for 7 months).
1915	1,307.97 "	1,282.68 "
1916	1,979.00 "	1,987.65 "
1917	1,929.06 "	1,896.00 "
	<u>5,887.10 lbs.</u>	<u>5,809.88 lbs.</u>

Notes on the experiments:—

(1) Each cooly tapped 400 trees per day, irrespective of whether trees had one cut or two cuts.

(2) Over the areas where the trees had single cuts, all cuts were opened at 20 inches from the ground. Trees on which two cuts were tapped had the upper cut at 36 inches from the ground and the lower cut at 20 inches from the ground.

(3) By the end of 1917, the bark renewal on trees which had been tapped with two cuts was so poor, that it was quite evident that this system of tapping was far too drastic.

(4) The yield obtained from a single cut was 98.69% of that obtained from a double cut.

Received for publication 8th September 1925.

A PRELIMINARY NOTE ON PINEAPPLE FIBRE.

BY R. O. BISHOP & E. A. CURTLER.

VARIOUS species of the Natural Order Bromeliaceae have long been known as potential sources of fibre and it appears that the variety *Ananas sativus*, known universally for its fruit, the pineapple, has for many years been recognised by the inhabitants of these parts as a plant of which the leaf contains a valuable fibre. It is reported¹ that in the Great Exhibition of London, 1851, pineapple thread of high quality was exhibited as having been made in Singapore, and the same writer² states that, in the East Indies, fibres of *Ananas sativus* have been extensively used for the manufacture of a fabric (Pina cloth) and cordage. (It appears however that Squier was referring to another variety of edible pineapple.) A sample of pineapple fibre was taken to England in 1893 by an Assistant Superintendent, Gardens and Forest Department, Straits Settlements and very favourably reported on by Messrs Ide & Christie³. A somewhat extensive investigation into the preparation of fibre from the leaves of the Red Spanish pineapple grown in Florida was reported by the U.S.A. Department of Agriculture in 1892⁴. From an Appendix to a Foreign Office Report (F.O. Commercial 1/1896) we learn that Pineapple fibre was at that time an article of commerce in the island of Formosa from whence it was exported to Swatow to be made into cloth. The fibre was valued at about \$24/- per picul⁵.

More modern publications contain however only brief references to the fibre obtained from the leaves of the edible pineapple plant, and there appears to be no information of a precise nature to meet the requirements of any capitalist likely to exploit pineapple fibre as an industrial enterprise. With the object of supplying this deficiency some experimental work has been carried out at the Department of Agriculture and the results are recorded in this article.

Commercial Valuation of the Fibre.—In August 1924 a representative sample of fibre was prepared from pineapple plants grown for the fruit canning factory at Klang, Selangor, and the sample was submitted to the Imperial Institute for valuation and report. The results of examination, indicate that the fibre is of good quality, and although only fairly well prepared, it would probably be saleable at about £50 per ton, if offered in commercial quantities. As the commercial valuation was slightly above that of first quality Sisal Hemp and approximately seventy five per cent. of the value of the finest Manila Hemp it appeared desirable to continue investigations by stripping fibre from the leaves of plants growing at the Government Experimental Plantation, Serdang.

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1. Tropical Fibres, Squier, page 37.
 2. Ibid.
 3. Kew Bulletin 1893 page 368.
 4. Kew Bulletin 1893 page 208.
 5. Kew Bulletin 1896 page 73.

Yield of Fibre.—The plants selected were of the "Singapore" variety which is the one grown in this country for canning factories. The fruit is about six inches long with a maximum girth of fifteen inches and an average weight of two and three quarter pounds. The leaves are dark green with a silver-grey cuticle on the underside. There are no spines on the edges of the leaves.

The plants were grown in a field of $8\frac{1}{2}$ acres situated on the eastern slope of a slight rise. The soil is a light sandy loam overlying laterite. The area in question carried no crop from the time it was cleared of jungle until the pineapple suckers were planted, except for a light growth of *Centrosema Plumerii* which was planted immediately after clearing, and ploughed in 12 months later, when the land was prepared for the pineapples.

The suckers, which had been obtained from Singapore, were planted in rows five feet apart across the face of the hill, with three feet between the individual suckers. Planting took place during February and March 1923. The leaves for fibre decortication were harvested during December 1924, and January to March 1925. Table 1 shows the yields of fibre obtained from the leaves cut in the respective months.

TABLE I.

Yield of fibre from Pineapple Leaves.

	Number of leaves.	Wt. of leaves. lbs.	Wt. of Fibre. lbs.	Percentage Yield of Fibre from green leaves.
Dec. 1924	40485	9102	104.5	1.14
Jan. 1925	42279	12400	124.75	1.00
Feb. 1925	34327	8675	88.25	1.01
Mar. 1925	47370	11185	113.625	1.01

A few leaves were harvested and decorticated prior to December.

Total Leaves Decorticated ... 169500

Total Weight of Wet Leaf ... 43240 lbs.

" " " " Dry Fibre ... 443.5 "

Yield of Dry Fibre/Wet Leaf ... 1.02 per cent.

The fruit of the pine was being harvested throughout this period of leaf gathering but the main crop of pineapples was not ripe until May/June 1925. The total yield of fruit harvested from the $8\frac{1}{2}$ acres up to the end of June 1925 was approximately 10,000 pineapples.

Although from field observations we are unable to record any definite ill effect caused by the stripping of these leaves it is thought that a better yield of both leaf and fruit would have been obtained if the leaf harvest had been postponed until May and June 1925 i.e. practically simultaneous with the gathering of the bulk of the fruit, but before any definite figures can be obtained it will be necessary to conduct more intensive trials and the history of the whole area would need to be recorded systematically over at least 3 years. As far as we can say at present the stripping of 20 tons of leaves from the 8½ acres has had no apparent effect.

The leaves, which have no spines along their edges, are harvested simply by pulling. A firm grip near the base of the leaf is sufficient to enable a coolie to strip the leaf from the plant stem with comparative ease.

The average dimensions of the freshly stripped leaves were :—

Length	... 43 inches
Width	... 2½ "
Weight	... 4 ozs.

The leaves, as shown in Table 1, were cut in quantities of five thousand at a time and transported to Kuala Lumpur, a distance of fifteen miles, where they were stripped at the rate of two thousand per day. It did not appear that the quality of the fibre deteriorated in any way by this delay in handling and, in comparison with Sisal Hemp, which is a more fleshy leaf, the pineapple leaves allow greater latitude in time and conditions of storage without showing the depreciation in colour and appearance of the finished fibre that is apparent in Sisal Hemp.

The fibre was decorticated from the pineapple leaves in two stages. The leaf was first run between the smooth rollers of a rubber machine, by means of which it was flattened and the surface cuticle on both sides of the leaf bruised and softened; the crushed leaf was then stripped in a raspador machine. It was found that the fibre after this treatment was still contaminated with adherent tissue which could only be removed by washing and scraping with a blunt knife. The raspador machine designed to deal with large succulent leaves such as Sisal could not be arranged to strip the pineapple leaves clean because the leaf cuticle is tougher and the fibre is very much finer than Sisal hemp. It was therefore only possible with the machine at our disposal to remove a portion of the surrounding tissue from the fibre filaments and, even then, great care had to be exercised with the adjustment of the raspador, to prevent loss of fibre. Doubtless, if the demand arose, a suitable machine could be devised but it is interesting to note that the U. S. A. Department of Agriculture Report on Fibre Investigations, 1892, comments on the same difficulty in extracting pineapple fibre⁷. The value of pineapple fibre was recognised many years ago by Ridley^{7, 8} but he concluded that the

7. Agr: Bull: of the Malay Peninsula. No. 3 May 1893 page 56.

8. Agr: Bull: Straits and F.M.S. Vol. IV. No. 1 Jan. 1905 page 6.

hardness of the epidermis of the leaf made it difficult to produce the fibre economically in large quantities.

The question of a suitable machine has a very important bearing on the commercial production of fibre from this and other species of Bromeliaceae and, as far as we are aware, there is still no efficient machine on the market for dealing with this class of fibres.

Quality of the Fibre.—The fibre when dry and brushed was submitted to an examination for tensile strength and chemical characteristics in comparison with standard specimens of Manila hemp. Well prepared pineapple fibre should find applications other than for cordage purposes, and it is known that the finest Manila Hemp,—Philippine Islands, Government Grade, Prime "A",—is used for semi-textile purposes and not cordage. It was thought therefore that such a fibre would afford the most useful criteria for evaluating pineapple fibre.

Microscopic examination of the ultimate fibres has not been carried out thoroughly, but the measurements so far made show that the fibre filament of the material under examination consists of bundles of ultimate fibres which have the same dimensions as those recorded by Vetillard⁶.

	Pineapple Fibre.	Prime Manila Hemp.	Linen.	Jute.
Length of Raw Fibre Filament in inches -	36.42	84.96	...	40.48
Mean length of Ultimate Fibres in millimetres -	5.0	6.0	25.0	2.0
Mean breadth of Ultimate Fibres in 1/1000 m.m -	6.	24.	20.	22.5

The tensile strength of the fibre was determined on a Schopper fibre Testing Machine according to the procedure adopted in testing fibres at the Department of Agriculture. The figures recorded in Table II show the results obtained. Each specimen of fibre is broken in two places—at either end—and the mean of the two breaking loads is used for calculating tensile strength in Kilos per unit gramme length.

TABLE II.

Tensile Strength Determinations on Pineapple Fibre.

Specimen No.	Weight of one Metre of Specimen grammes.	Mean Load at Break. (Kilos.)	Mean Tensile Strength. (Kilos per unit gramme metre.
1	0.2856	9.9	34.6
2	0.3541	8.6	24.3
3	0.2717	6.4	23.5
4	0.2002	5.6	27.9
5	0.2833	8.2	28.9
6	0.2735	8.9	32.5
7	0.2413	6.2	25.6
8	0.2813	9.9	32.5
9	0.4080	13.0	31.8
10	0.3140	8.8	28.0
11	0.2499	6.1	24.4
12	0.2723	7.2	26.4
13	0.1866	6.7	35.9
14	0.2215	6.6	29.7
15	0.2280	5.3	23.2
16	0.2400	7.7	32.0
17	0.2400	6.4	26.6
18	0.2901	6.8	23.4
19	0.2960	8.5	21.7
20	0.3251	7.3	22.4
21	0.3003	9.3	30.9
22	0.2187	6.0	27.4
23	0.2085	6.6	31.6
24	0.2896	8.0	27.6
25	0.3120	7.3	23.4
26	0.2773	10.5	37.9
27	0.2960	9.0	30.4
28	0.2632	6.5	24.6
29	0.2187	7.5	34.2
30	0.3821	9.4	24.6

TABLE II.—(contd.)

Tensile Strength Determinations on Pineapple Fibre.—(contd.)

Specimen No.	Weight of one Metre of Specimen grammes.	Mean Load at Break (Kilos.)	Mean Tensile Strength. (Kilos) per unit gramme metre.
31	0.2845	8.6	30.2
32	0.2592	8.3	32.0
33	0.2720	8.7	32.0
34	0.3645	9.8	26.8
35	0.2912	7.8	26.7
36	0.2037	6.2	30.4
37	0.2509	7.2	28.6
38	0.1701	4.9	28.8
39	0.2866	8.5	29.6
40	0.2037	6.9	33.8
41	0.2880	7.7	26.7
42	0.2811	7.2	25.6
43	0.2784	8.2	29.4
44	0.2027	4.4	21.7
45	0.2757	9.4	34.0
46	0.2941	9.1	30.9
47	0.2698	8.7	32.2
48	0.2226	6.6	29.6
49	0.2720	6.5	23.9
50	0.2976	8.9	29.9

True mean of 50 terms = 28.58 Kilos per unit gramme metre.
 Standard Deviation ± 3.91

Each specimen consisted of 20 fibres. The Breaking Load was determined in two positions. The testing length, that is the distance between the fixed jaws of the machine at the commencement of the application of the load was 20 centimetres.

For comparison the mean Breaking Strengths of some other fibres are recorded in Table III. These figures were determined on the same machine in the precisely same manner.

TABLE III.

Comparative Tensile Strengths of Various Fibres.

Sample.	Description.	No. of Specimens Tested.	Average weight of sample (Grammes)	Mean Breaking Loads (Kilos).	Mean Tensile strength (Kilos per unit gramme metre)	Standard Deviation of Tensile strength from Mean.
1	Manila Hemp "Extra Prime" Government Standard	10	0.3929	18.0	46.1	5.1
2	Manila Hemp "Superior Current" Government Standard	10	0.517	20.1	40.05	6.3
3	Pineapple Fibre from canning pine leaves	50	0.2699	7.7	28.58	3.9
4	Manila Hemp from locally purchased imported Manila Hemp Cordage.	10	0.5784	13.2	23.33	4.9

The chemical characteristics of the fibre were determined on two lots of 100 grammes taken from the whole parcel of fibre. The procedure adopted is that described by Cross and Bevan and followed by the Imperial Institute. Results are recorded in Table IV together with some comparative results for Manila Hemp and Pineapple Fibre sent to the Imperial Institute from the Gold Coast.

TABLE IV.

Results of comparative Chemical Examination of Pineapple Fibre.

Sample.	Moisture.	Results calculated on the "Moisture-free" Sample.					
		Ash.	Loss on washing with water.	Loss on washing with acid.	Hydrolysis "A" Loss.	Hydrolysis "B" Loss.	Cellulose content.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Pineapple Fibre from canning pines grown at Klang -	9.7	0.8	0.9	2.2	14.7	17.0	79.0
Pineapple Fibre A. from canning pines grown at Serdang -	11.35	0.57	nil	1.01	12.17	18.18	81.70
Pineapple Fibre B. from canning pines grown at Serdang -	11.67	0.54	2.15	3.45	17.12	19.81	...
Pineapple Fibre C. From canning pines grown at Serdang -	11.32	1.2	...	...	14.69	17.87	83.09
Manila Hemp Grade A. "Extra Prime" from Dept. Agriculture, Philippine Islands -	9.70	1.20	0.17	0.55	12.62	17.61	76.66
Pineapple Fibre from Gold Coast, Africa, Examined at Imperial Institute A.C. 153/25	9.5	1.1	...	1.07	13.7	19.14	81.5

OBSERVATIONS AND CONCLUSIONS.

From the figures recorded in Tables III and IV it is evident that the fibre prepared from the leaves of the fruiting pineapple plant of the "Singapore" variety possesses a comparatively high tensile strength and is a high grade fibre. The fibre is fine in staple and lustrous, with a soft silky texture. The investigations in connection with spinning and weaving are not yet complete but there is no doubt that the physical and chemical characteristics are sufficiently encouraging to warrant further trials.

With regard to the cost entailed in producing this fibre the size of the experiment precluded the detailed organisation necessary for economic working. Compared with a crop such as Sisal or Manila the cost of collection is high, because the pineapple leaves are small and the percentage of fibre is low. The 4 cwts. of fibre produced here necessitated the collection of approximately 20 tons of fresh leaves. This disadvantage is again apparent in the handling of the leaves in the factory. The comparative difficulty of obtaining a clean sample of fibre is another factor which would militate against a low cost of production and therefore we are of opinion that, although pineapple fibre can be obtained as a bye-product from the cultivation of canning pines, the present investigation does not indicate that it would be very profitable as a commercial enterprise.

Received for publication 7th September 1925.

THE EFFECT OF TAPPING COCONUT PALMS FOR TODDY ON THE COPRA AND OIL PRODUCED FROM SUBSEQUENT FRUITING.

By H. W. JACK AND J. H. DENNETT.

THOUGH it is well known that coconut palms which have been tapped for toddy are stimulated temporarily to produce heavy crops of fruit after the cessation of tapping, little is known of the duration of such stimulation or of its effect on the quality of the copra or its oil content.

Malays commonly affirm that the oil extracted from coconuts which have been collected from palms previously tapped for toddy makes a sweeter cooking oil than oil from coconuts collected from palms which have never been tapped, but that the meat from nuts from tapped palms contains less oil than meat from nuts of untapped palms. Moreover, they state that the meat in nuts collected from palms which have previously been tapped for toddy is thinner and less compact, and that they produce less copra per nut than nuts collected from untapped palms.

The commercial planter is not much concerned as to whether his copra contains a sweet cooking oil, but the question of the amount of copra he can obtain from his nuts is a significant factor in his costs of production and as such, warrants his attention. For this reason and in order to ascertain whether tapping for toddy really affected the quantity or the quality of the oil, the following experiment was conducted.

Through the courtesy of Mr. H. L. Carter, Manager of Dusun Durian Estate, 100 ripe coconuts gathered at random from palms which had never been tapped for toddy and 100 ripe nuts collected from adjacent trees which had previously been tapped for toddy, the tapping having been stopped two years prior to the time of collection, were obtained.

The palms from which both lots of nuts had been collected were planted at the same time and were growing in typical coastal alluvial loam under apparently similar conditions.

Records were carefully compiled from each lot of nuts (approximately 50 nuts being analysed in each case), and are shown in Tables A & B. From tables A & B the following averages per nut are extracted as expressed in Columns 1, 2 and 3 below, from which Columns 4 and 5 are calculated.

—	1. Wt. of Meat. grms.	2. Mois- ture on meat. per cent.	3. Oil on dry meat. per cent.	4. Wt. of dry meat (copra) in grms.	5. Wt. of oil per nut in grms.
Untapped palms	511	51.5	66.5	263.2	175.0
Tapped palms	490	49.5	63.2	242.5	153.3
Differences	21	2.0	3.3	20.6	21.7

These figures show that nuts from untapped palms contain 8.5 per cent more dry meat or copra and that the meat contains 14.2 per cent more oil than nuts obtained from palms which had been tapped for toddy two years prior to the time of collection of fruit. The increase, in the case of the copra, is insignificant, since the difference lies within the limits of the probable error (9.5 per cent) of the records, but the difference in the matter of oil content is of material import, since the increase is more than twice the probable error expressed as a percentage (6 per cent) of the mean oil content. Though the figures for copra production per nut do not definitely prove injurious effects resulting from tapping, they indicate fairly definitely a tendency in that direction which might have been accentuated had a larger number of nuts been treated in the experiment. Moreover, had the nuts been collected from tapped palms, after the lapse of a shorter interval of time than two years following the cessation of tapping, it is probable that the tendency to produce less copra per nut might have been emphasised materially.

It might be mentioned that the difference of approximately 21 grammes per nut would on an average plantation yielding 2,500 nuts per acre per annum result in a loss, by tapping for toddy, of 1 cwt. of copra per acre. At the same time it is likely that, under good conditions, the stimulation in nut production due to tapping might so increase the number of nuts per acre as to counterbalance the loss due to decrease of copra per nut. Unfortunately there are no available records to show how long the stimulation produced by tapping is continued, though the majority of experienced observers agree that it is only temporary, but it is clear that it would require several years of stimulated production to compensate for the year following the cessation of tapping, when nut production would be practically nil.

The deficiency in oil content of copra derived from nuts collected from tapped palms is of no significance to the producer who markets his product as "copra" which is not bought by the manufacturers on any oil content basis (as far as the writers are aware) though preference in buying is given to producers in certain localities which have established a reputation for good well dried copra. Nevertheless, the manufacturer who buys copra obtained from tapped palms, loses approximately 22 grammes of oil per nut, or about 180 lbs. of oil for every ton of copra milled. This is equivalent to a loss to the manufacturer of about £3.10.0 on every ton of copra milled, assuming the price of coconut oil to be £40 per ton.

Fortunately the number of bearing palms used for toddy tapping is only a small percentage of the total number of palms grown for copra production, at least in Malaya, so that the commercial product is little affected by the mixture of copra from tapped palms.

THE DETERMINATION OF THE OIL CONTENT.

The nuts were opened and the various parts weighed as soon after arrival as possible and an average sample of the meat from each

nut (in the form of thin slices taken through the meat) was dried in the steam oven to obtain the moisture content.

This dried sample was used for the determination of the oil content. The oil was extracted with chloroform, and the following constants were determined from average samples.

CONSTANTS.

	Refractive Index at 28.5°C	Iodine Value per cent.	Saponification Value (m. grms. KOH per 1 gram oil.)
Tapped	1.4535	6.6	261
Untapped	1.4538	5.7	267
Lawkowitsch's figures for pressed coconut oil.	1.441 C 60°C.	8.0-9.5	257.3-268.4

The physical constants for the oils obtained from both tapped and untapped palms show no significant differences.

Received for publication 12th May 1925.

TABLE A.—UNTAPPED PALMS.

Weight of Nuts. (Gms.)	Weight of Shell. (Gms.)	Shell. (per cent.)	Weight of Meat. (Gms.)	Meat. (per cent.)	Volume of Milk. (c.c.s.)	Milk. (per cent.)	Oil on Nut. (per cent.)	Moisture on Meat. (per cent.)	Oil on Meat. (per cent.)	Moisture + Oil on Meat. (per cent.)	Oil on dry Meat. (per cent.)
1467	330	22.4	607	41.4	530	36.2	11.6	57.6	28.0	85.6	60.5
1360	257	19.0	575	42.3	530	39.0	11.7	54.6	27.8	82.4	61.5
1555	325	20.8	540	34.8	690	44.4	16.2	53.5	26.5	80.0	58.0
1580	320	20.2	650	41.2	630	39.5	11.9	54.7	29.4	84.1	64.0
950	325	34.2	455	48.0	270	28.4	13.8	39.4	27.9	67.3	46.2
1025	330	32.2	465	45.4	330	32.2	16.2	44.5	35.8	80.3	64.5
1080	225	20.8	520	48.2	270	25.0	17.0	51.0	33.4	84.4	68.0
1280	260	20.3	510	39.8	510	39.5	11.0	53.5	27.9	81.4	60.0
1310	290	22.2	570	43.5	450	34.4	11.7	56.6	27.4	84.0	62.5
970	240	24.7	445	45.8	285	29.5	9.5	62.8	20.7	83.5	55.5
1340	280	20.8	550	41.1	505	37.6	15.1	44.3	29.1	73.4	65.7
1090	250	23.0	410	38.7	410	37.7	11.4	50.6	30.3	80.9	61.5
1480	330	22.0	620	41.9	530	35.8	12.3	52.7	19.8	82.5	61.0
1010	220	21.5	440	43.5	350	23.6	17.7	42.4	41.0	83.4	71.0
1400	250	17.8	660	47.0	590	42.2	7.8	69.3	16.7	86.0	54.3
1710	325	19.0	630	36.8	755	44.1	9.7	51.8	26.4	78.2	54.7
1120	260	23.2	450	40.5	410	36.8	12.5	51.9	31.2	83.1	64.7
1080	270	25.0	440	40.7	350	32.4	13.1	48.0	33.5	81.5	64.5
1030	240	23.4	470	45.5	320	31.3	13.7	51.5	29.2	80.7	60.4
1090	240	22.0	500	46.0	350	32.1	10.8	61.8	22.1	83.9	58.0
1230	250	20.3	530	43.0	450	36.6	13.6	51.3	31.9	83.2	65.5
1000	200	20.0	500	50.0	300	35.0	16.0	48.9	31.9	80.8	62.5
1250	260	20.7	510	40.8	380	30.4	11.4	55.3	28.0	83.3	62.7
990	280	28.5	510	51.5	200	20.2	10.2	63.9	19.1	83.0	53.0

TABLE A.—UNTAPPED PALMS.—(contd.)

Weight of Nuts. (Gms.)	Weight of Shell. (Gms.)	Shell. (per cent.)	Weight of Meat. (Gms.)	Meat. (per cent.)	Volume of Milk. (c.c.s.)	Milk. per cent	Oil on Nut. (per cent.)	Moisture on Meat. (per cent.)	Oil on Meat. (per cent.)	Moisture + oil on Meat. (per cent.)	Oil on dry Meat. (per cent.)
1300	250	19.2	550	42.5	450	34.6	14.7	49.0	34.6	83.6	67.8
1320	280	22.0	540	40.9	500	37.9	13.0	52.8	31.8	84.6	67.5
1580	300	19.2	680	42.7	600	38.0	13.9	50.4	32.2	82.6	65.0
1080	240	22.5	460	42.6	380	35.2	13.3	48.8	31.2	80.0	60.9
1220	270	22.2	500	41.0	450	36.7	13.3	48.9	32.4	81.3	63.5
1270	260	20.4	570	44.8	440	34.7	17.1	41.3	38.0	79.3	64.7
1120	260	23.2	500	44.7	360	32.2	18.4	42.7	41.1	83.8	71.8
1200	250	20.7	550	45.7	400	33.5	16.4	51.8	35.8	87.6	74.3
920	200	21.7	420	45.6	300	36.4	18.0	44.8	36.1	80.9	65.5
930	240	23.6	370	39.8	320	36.8	15.4	46.6	36.0	82.6	67.5
1610	350	21.6	580	39.0	680	42.0	10.5	47.2	29.1	76.3	55.2
970	240	26.5	420	44.5	310	33.0	9.9	59.8	22.1	81.9	55.0
1200	250	20.8	550	46.0	400	33.3	14.3	51.8	31.3	83.1	64.7
920	200	23.6	420	49.7	300	35.5	17.9	44.8	35.7	80.5	64.6
930	240	27.8	370	42.7	320	37.2	15.3	46.5	35.5	82.0	66.5
1450	320	22.0	600	41.5	530	36.5	11.2	52.7	35.5	79.8	57.2
1020	240	23.5	470	46.0	310	29.7	15.7	45.8	34.1	79.9	63.2
1040	230	22.2	490	47.0	300	28.8	15.8	50.5	33.6	84.1	67.9
1630	300	18.4	700	43.0	630	33.6	12.1	58.4	28.0	86.4	67.3
950	200	22.3	400	44.4	350	38.8	14.3	50.5	32.1	82.6	64.8
1390	300	21.6	640	46.1	450	32.4	10.3	54.5	22.3	76.8	48.9
1170	230	19.7	480	41.2	460	39.3	13.0	49.0	21.6	80.6	62.0
1185	265	23.2	511	43.1	42.7	36.2	13.8	51.5	32.5	84.0	66.5

TABLE B.—TAPPED PALMS.

Weight of Nuts.	Weight of Shell.	Shell of	Weight of Meat.	Meat.	Volume of Milk.	Milk.	Oil on Nut.	Moisture on Meat.	Oil on Meat.	Moisture + Oil on Meat.	Oil on dry Meat.
(Gms.)	(Gms.)	(per cent.)	(Gms.)	(per cent.)	(c.c.s.)	(per cent.)	(per cent.)	(per cent.)	(per cent.)	(per cent.)	(per cent.)
1492	247	12.6	635	42.5	610	38.4	13.9	48.3	32.5	80.8	63.0
1042	212	19.4	480	46.0	350	33.5	15.4	48.7	33.4	82.1	68.0
1146	226	18.8	520	46.6	400	35.0	12.0	55.0	26.5	81.5	62.3
1244	250	20.2	544	42.8	450	36.1	11.4	53.7	26.2	79.9	62.5
1069	222	19.6	487	45.5	360	33.8	17.6	45.0	35.6	80.6	64.9
1090	205	18.8	555	50.9	330	30.4	17.6	46.5	34.7	81.2	45.0
860	180	20.8	425	49.5	255	29.2	15.4	51.6	31.0	82.6	64.0
1374	312	22.5	682	49.6	460	33.5	11.7	55.0	26.8	81.8	59.8
1065	225	21.2	470	44.2	370	34.8	12.9	62.8	29.4	92.4	80.0
1140	240	21.0	520	45.6	340	29.8	17.3	41.9	37.8	79.7	65.1
1020	230	22.5	430	42.3	360	36.2	15.6	44.3	37.1	81.4	66.6
1010	230	22.7	420	41.5	360	36.4	11.1	54.6	26.8	81.4	59.5
1300	320	24.6	560	43.0	420	32.4	12.7	55.4	29.4	84.8	66.0
980	220	22.2	420	42.8	340	34.8	13.5	49.4	31.1	80.5	62.3
960	210	20.7	470	49.0	280	29.2	18.7	45.5	38.3	83.8	69.9
1040	230	22.0	510	49.0	300	28.8	14.7	50.0	30.1	80.1	60.0
755	165	21.9	405	53.5	185	24.5	15.1	43.5	33.1	76.6	58.5
1110	240	21.6	470	42.4	360	32.5	12.7	50.6	30.2	80.8	60.7
1290	280	22.5	610	47.4	600	46.5	14.6	49.9	31.7	81.6	63.3
1055	280	26.6	430	40.7	240	22.8	12.1	47.8	32.5	80.3	62.3
1010	240	24.0	440	42.4	330	30.2	14.3	45.1	32.5	77.6	59.4
1210	270	22.3	570	47.1	360	29.8	16.4	49.3	34.5	83.8	68.0
1140	240	19.4	580	50.8	380	33.5	16.5	39.2	31.8	71.0	52.2
960	200	20.8	440	45.8	320	34.4	14.9	51.8	31.3	83.1	64.9
1450	350	24.1	500	34.5	600	41.4	10.5	51.2	30.4	81.6	62.5
1190	250	21.0	590	49.6	350	29.5	13.3	53.7	26.7	80.4	57.7
1100	230	20.8	500	47.8	370	33.5	13.3	49.5	29.2	78.4	57.9
880	200	22.4	400	45.5	280	31.9	16.5	51.2	30.2	81.4	70.6

TABLE B.—TAPPED PALMS.—(contd.)

Weight of Nuts.	Weight of Shell. (Gms.)	Shell. (per cent.)	Weight of Meat. (Gms.)	Meat. (per cent.)	Volume of Milk. (c.c.s.)	Milk. (per cent.)	Oil on Nut. (per cent.)	Moisture on Meat. (per cent.)	Oil on Meat. (per cent.)	Moisture + Oil on Meat. (per cent.)	Oil on dry Meat. (per cent.)
1390	250	18.0	580	41.7	560	40.3	14.4	55.5	34.4	89.9	77.2
1090	220	19.4	480	44.0	390	35.8	11.1	57.1	25.3	82.4	59.0
1175	270	23.1	480	40.8	425	36.1	13.4	44.5	32.3	76.8	58.2
1110	220	20.7	510	46.0	380	35.8	14.3	50.9	31.2	82.1	63.6
1160	250	21.6	500	43.0	410	35.4	13.4	48.9	31.3	80.2	61.2
990	210	21.2	450	45.5	330	33.7	13.3	51.6	29.2	80.8	60.3
1020	200	19.8	490	48.0	320	31.5	14.3	57.6	29.8	87.4	70.2
1420	300	21.1	620	43.6	500	35.3	11.9	53.3	27.2	80.5	58.2
1060	240	22.6	470	44.4	350	33.0	13.3	49.1	30.2	79.9	59.3
1000	270	27.0	430	43.0	300	30.0	13.8	49.7	34.9	83.7	67.5
1400	340	24.3	620	44.2	370	26.5	14.2	51.8	31.8	83.6	65.9
1230	280	22.7	570	45.6	340	30.9	17.1	41.4	35.6	77.0	60.7
1000	240	24.0	440	44.0	320	32.0	15.2	50.6	34.5	85.1	69.8
1400	340	24.2	580	41.5	480	34.3	9.7	55.1	23.5	78.6	52.8
1040	270	25.8	450	43.4	320	30.8	12.7	50.2	28.1	78.3	56.4
1010	240	23.7	500	49.5	270	27.0	18.3	44.1	36.9	81.0	66.0
1150	260	22.6	480	41.7	160	13.9	18.7	37.0	44.6	81.6	70.8
1060	240	22.6	450	42.4	370	35.0	12.8	52.8	30.2	83.0	64.0
1030	250	24.3	460	44.5	320	31.0	15.6	45.9	35.9	80.9	64.7
1060	260	24.5	460	43.2	320	30.2	12.6	51.0	28.8	79.9	58.7
1370	330	24.2	580	42.3	460	33.6	12.9	50.5	30.5	81.0	61.6
920	180	21.2	450	53.2	270	32.9	16.9	48.5	31.6	80.1	61.3
1050	250	23.7	330	31.5	470	44.5	11.5	42.5	36.5	79.0	63.4
940	200	22.7	440	50.0	300	34.0	14.4	46.0	28.9	74.9	53.5
1160	240	20.5	540	46.6	380	32.7	17.1	49.9	36.6	86.5	73.0
1116	241	21.5	490	43.9	364	32.5	14.1	49.5	32.0	81.5	63.2

SAPUCAIA NUTS.

BY W. N. SANDS.

BESIDES the Para Rubber tree (*Hevea brasiliensis*, Mull.) two other important South American trees have been successfully introduced to cultivation in Malaya in recent years; these are the Brazil Nut (*Bertholletia nobilis*, Miers.) and one of the Souari or Piqui'a Nuts (*Caryocar villosum*, Pers.) In view of the gratifying results which have followed these introductions, efforts are being made by the Department of Agriculture to obtain from Brazil another highly-prized nut, namely the Sapucaia Nut which is derived from a species of *Lecythis*. It is said that this nut is superior to the Brazil Nut in flavour and quality. It would appear that the Sapucaia Nut exported from Brazil is derived from *Lecythis usitata*, Miers., although other species of the same genus, e.g., *L. Zabucayo*, Aubl.; *L. lanceolata*, Poir., and *L. Pisonis*, Camb., are also known to produce edible nuts.

Miers¹, writing in 1875, states that "the seeds of a species of *Lecythis* abundant in the Province of Para are exported to Europe in considerable quantities and sold there in the shops as Sapucaia Nuts," and again that "*L. usitata* is the species which produces the well-known Sapucaia Nuts of commerce; and it is very different from *L. Zabucayo*, Aubl." At the present time, however, the chief exports appear to go to the United States of America, for in a letter dated 27th October 1923, received from the Assistant Director of the Royal Botanic Gardens, Kew, it is stated that "owing to the lack of demand for the nut in this country the whole of last season's stock was exported to America."

Mr. L. A. Emerson, late of Tembeling, Pahang, who resided for some time in Brazil, has been good enough to supply the following interesting information concerning the nut derived no doubt from *Lecythis usitata*, Miers.

"The tree is indigenous to the tropical rain-forests or "Selvas" of North Brazil; but is also found in the Republics of Peru, Colombia, and Venezuela, in the districts which border Brazil.

"The chief export is from the Amazon River via the Port of Santa Maria de Belem do Para.

"This nut fetches a much higher price on the European markets than does the "Castanha" or Brazil Nut (*Bertholletia excelsa*) owing to its superior flavour for one thing, but chiefly due to the difficulty of collection.

"Sapucaya nuts are contained in a large, heavy, woody pot-shaped receptacle, closed by a natural lid. Monkeys twist the fruit off the tree; the impact of the fall forces off the lid, and the seeds or

nuts are scattered. As the "shell" of the nut itself is comparatively soft, peccaries, monkeys, and the large rodents peculiar to South America, soon devour the scattered seed, and that which escapes the Fauna, quickly germinates or rots on the damp leaf-mould of the forest-floor.

"Whereas of course the Brazil-nut, with its immensely strong woody seed-pod, can lie on the ground for months, and nothing can get at the nuts inside. In fact the pod has to be broken with sledge hammers before the nuts can be shipped.

"Another reason for its higher market price is that Brazil consumes a considerable quantity herself, which is not the case with the Brazil-nut which is collected almost entirely for export.

"Like the Brazil-nut, the Sapucaya contains a considerable quantity of natural oil. The Brazilians believe this oil has medicinal properties; and the Incas of Peru—according to the Spanish Archives—are said to have expressed the oil in crude presses for use as a drug.

"Owing to its soft shell, I should imagine that the transport and storage in bulk of Sapucaya nuts was a much more difficult problem than Brazil-nuts.

"The seed-pod is a large, heavy, woody, pot-shaped receptacle which may contain 20 to 30 nuts.

"The nuts are packed loosely inside the pod. The stem of the fruit is at the opposite end to the "lid" of the receptacle.

"The lid is circular, its inner edge being bevelled to fit the correspondingly bevelled edge of the pot-rim.

"The walls of the receptacle vary from $\frac{1}{2}$ " to $\frac{3}{4}$ " in thickness, and are of a hard cinammon-coloured wood. The shape is invariably symmetrical.

"The tree grows in the same forest areas as the Brazil nut, but is not nearly so plentiful due to the afore-mentioned causes.

"The seed or nut is oblong in shape and about 2" long. The skin or shell is of a cinammon colour, and grooved something like an English peach-stone, but more symmetrically. When fresh the shell can be removed with the thumb-nail, exposing the white kernel beneath. The flavour of the fresh seed has a slight resemblance to that of the Kentish "Cob" Nut; but is of course more oleaginous than the latter. The shell or skin of the seed is about 1 mm. in thickness.

"With regard to the alleged medicinal properties of the oil obtained from the nut, foreign and Brazilian doctors have told me they think that there is little in this."

Of other species producing edible nuts little information has been obtained so far. Miers (loc: cit) mentions that *Lecythis Zabucayo*, Aubl., was introduced into Mauritius from Cayenne by the Comte D'Estaing who, during a visit to Cayenne in 1758, was so delighted with the seeds of the *Zabucayo* that he carried away with him twelve living plants of the tree and planted them in the garden at Reduit. Another species, *L. lanceolata*, Poir., which is known as *Sapucaia blanca*, is found in Guiana. According to Rodrigues¹ it yields seeds which are eaten either boiled or raw and which are considered narcotic. With the paste extracted from the seeds, emulsions are prepared which are used as a remedy against affections of the urinary canal. He also states that *L. Pisonis Camb.*, also known as *Sapucaia* in Brazil, produces seed which are eaten either raw or roasted.

All of the species named are large jungle trees of the tropical rain forests of South America, and there appears to be no reason why they should not thrive in Malaya as well as the other valuable ones mentioned at the commencement of this article.²

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1. Miers, J.—On the Lecythidaceae, Trans. Linn. Society. Vol. XXX, pp. 157-318 (1875).
2. Rodrigues, J. B.—Hortus Fluminensis ou Breve Noticia Sobre Plantas Cultivados no Jardim Botanico Do Rio de Janeiro. Jan: 1894.

Received for publication 22nd August 1925.

NOTE.

Calopogonium mucunoides is usually stated to be intolerant of shade and useless as a cover plant for old rubber areas.⁽¹⁾

In this connection it is of interest to report that on Bukit Kiara Estate, Kuala Lumpur, this legume has been grown since 31.1.25 as a cover crop on a small scale, amongst rubber trees planted in the year 1913. The trees are spaced 15' by 15' and provide moderate shade over the land. The soil is a light sandy loam. Previous to broadcasting the *Calopogonium* seed the surface soil was slightly stirred and a small application of cattle manure applied.

I inspected this cover crop on the 4th of September, 1925, and found the plant thriving and giving a satisfactory cover. The crop was seeding at the time of my visit.

F. G. S.
4-9-25.

(1) *Calopogonium mucunoides*. Malayan Agricultural Journal, Vol. XIII. No. 8, August 1925, page 271

(2) Since writing the above the writer learns that a small supply of the nuts for planting has been received by a local estate.

W. N. S.

Publications of the Department of Agriculture.

The following publications, except those out of print, may be obtained on application to the Office of the Secretary for Agriculture; and the Malay States Information Agency, 88, Cannon Street, E.C. London.

A remittance to cover the cost should accompany applications; otherwise the Journals will be sent by post, Cash on Delivery, where that system is in force.

1. The Agricultural Bulletin F.M.S.

Vols. I—IV (1913-16) VIII & IX (1920-21) price \$5.00 per volume.

Vol. V (1917) Nos. 1, 2, 3, 5 & 6 „ 2.50 per set.

„ VI (1918) „ 1, 7, 8 & 12 „ 2.00 „

„ VII (1919) „ 2—6 „ 4.50 „

2. The Malayan Agricultural Journal (continuing the Agricultural Bulletin). Published monthly.

Vol. X (1922) Price \$5.00 per volume.

„ XI (1923) Price \$5.00 per volume or 50 cents per single number.

„ XII (1924) „ „ „ „

Back numbers of Vols. I—X will not be sold singly.

3. The Handbook of Malayan Agriculture, price \$1.00.

Current numbers of the Malayan Agricultural Journal and the Handbook may be purchased at the Railway Bookstalls and Branches of Messrs. The Federal Rubber Stamp Co.

4. Special Bulletins.

1. Notes on *Termes Gestroi* and other species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909, 20 cts.
2. Root Diseases of *Hevea Brasiliensis*, by W. J. Gallagher. C
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910, reprint 1916, 20 cts. (Out of Print.)
4. A Lepidopterous Pest of Coconuts, *Brachartona catoxantha*, Hamps, by H. C. Pratt, 1909. C
5. The Extermination of Rats in Rice Fields, by W. J. Gallagher, 1909. C
6. Preliminary note on a Branch and Stem Disease of *Hevea Brasiliensis*, by W. J. Gallagher, 1909. C
7. *Coffea Robusta*, by W. J. Gallagher, Government Mycologist, 1910, 20 cts.
8. The Cultivation and Care of the Para Rubber Tree (in Malay) 1910. C
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C = Cancelled